

Committee Report

NSLS-II Project Advisory Committee Meeting

May 24-25, 2007

Members Present:

R. Hemley, Carnegie Institute of Washington
W. Hendrickson, Columbia University
T. Mason, Oak Ridge National Laboratory, Chair
G. Shenoy, Advanced Photon Source
A. Wrulich, Paul Scherrer Institute

Members Absent:

G. Materlik, Diamond Light Source
W. Stirling, European Synchrotron Radiation Facility

PAC members want to thank all presenters for taking time to inform the Committee of the progress and for their forthright answers to questions raised by the committee. We also thank the Lab Director for spending most of the time participating in the committee deliberations. This enforced to the Committee that NSLS-II project has a very high priority at the Laboratory.

Overall we found NSLS-II well positioned for the next phase in the project. An area of particular concern, which needs addressing as a matter of priority, concerns the Experimental Facilities; this includes the identification of its permanent Director as well as the plans for the first set of beamlines. The Director needs to be in place very soon in order to finalize the organizational structure for the Division and the policies that will govern Beamline Advisory Teams (BATs) and beamline selection; the community needs to be actively engaged now in beamline planning.

Project Management & Organization:

- The PAC is very pleased with the progress made towards CD-2 requirements and has confidence that all aspects of the project will be ready for a CD-2 review and EIR. The footprint of the accelerator systems, experiment hall, LOBs and ancillary support buildings are ready to be frozen with minor improvements planned during the next few months prior to the reviews.
- The PAC was impressed by the presentations from the Deputy Project Director and the Project Support Division, their understanding of the future needs of the project and their dedication to reach the goal. Various task groups and tools (HR, Procurement, MIS, etc.) assembled for project management is appropriate; in particular to address DOE required Compliant Earned Value System.
- The Committee was impressed by the assembly of strong HR, Communication, and Procurement cells within the NSLS-II project. We would like to hear about their plans and accomplishments, particularly from HR and Procurement, at the next meeting.
- Special mention must be made of the ESH team which is fully on board on all aspects of the project. Qualified personnel have been added to the team assuring smooth integration with the Lab ESH group. The team has clearly identified the needs to establish a safe work environment during the entire construction project.
- All major compliance requirements for the project have been clearly identified. An outstanding issue is the double redundancy requirement for critical safety functions both in the accelerator systems and x-

ray beam delivery systems. A decision should be reached shortly so that the design and costing of these systems would be appropriate at the CD-2 review.

- The presentation on JPSI was very impressive, its goals are commendable, and the leadership should be applauded for clearly articulating the plans. The PAC supports this initiative for its long term impact on the future of the user science program both at NSLS and NSLS-II. The activities of JPSI should hence be started soon and the PAC strongly recommends that every effort be made to provide LDRD funds in FY 2008 towards this goal. It is important to note JPSI serves an important role as an incubator for intellectual ideas on forefront science problems to be addressed at NSLS-II. The partnership between BNL and NY State legislature in support of JPSI building has to be applauded. We would like to caution that such state funded projects do not leave any room for cost overruns and hence should be carefully managed. The overruns should not become a burden either to DOE or to Lab management. An approach would be to plan for some scope contingency so that adjustments can be made in the event of unfavorable bid experience.

Taking leadership in detector development activity is appropriate for JPSI. If this is conceived as a national leadership area for BNL, the activity can perhaps stand on its own, reporting to the NSLS director.

- The PAC members are very pleased to learn that a permanent leadership of Accelerator Facilities will be on board in July 2007. The identification of permanent leadership for Experimental Facilities is the topic of greatest concern to the PAC. This is a very high priority action item for the ALD and the Lab Director. PAC members are always available to help in this search.
- The PAC is equally pleased to learn about the hiring of the interface managers. We would like to have presentations from them in the next meeting specifically to understand how they evaluate their role in the project and what tools that they plan to use in performing their jobs.
- The project as a whole should develop clear guidelines for change control for scope, cost and schedule. Delegated responsibilities (for change authorization) in such a process at various working levels of the project should be established along with the working rules for the change control board.
- In preparation for CD-2, the PAC strongly recommends that the entire WBS be revisited with a fresh mind to assure any missing elements, include updated scope, and checked by an independent group for functional relationships. All cost estimates should be freshly performed since the project personnel have now gained better insight into the project. Adequate funding should be included in the budget for project personnel to visit the vendors during the fabrication and acceptance tests of subcomponents. It is the experience of the PAC that such visits keep the vendors on schedule and identifies vendor performance problems in advance.
- Regular training classes should be planned to educate the group leaders (or task leaders) on their responsibilities and on project management tools. Special guidance must be given to project personnel in communicating (or not) with vendors emphasizing their strict adherence to the procurement rules.
- It is not clear to the PAC who manages the WBS 1.02: R&D and Advanced Conceptual Design. The elements belong organizationally to two technical divisions. We suggest that they be transferred under appropriate subsystems in 1.03 and 1.04 as a low level WBS element. This will provide direct management of the planned R&D activities. Alternatively a matrix clearly defining technical responsibilities should be developed and an R&D coordinator to oversee the budget appointed.
- ASAC and EFAC can only give broader guidance to the project progress. Hence, small independent committees should be appointed to review engineering designs of subsystems (by WBS at 4th level or so) from concept to their completion. Such committees are mainly made up of personnel from national labs with good project experience. Design reviews at appropriate stages in the design should be identified in the schedule for major subsystems.

- The management and funding of ‘spares’ is a big challenge during operations. The PAC would like to hear at a future meeting the process that defined the ‘process spares’ and how they will be funded and managed. Such a presentation may be required at the CD-2 review.
- It is important that the staff fully understands the craft codes used in the collection of costing data and the applicability of ‘Davis-Bacon’ and M&S rates to specific tasks. Overheads on BAT generated funds and matching funds (especially non-BES funds) should be minimal. These overheads should be negotiated with Lab management and DOE in advance and made available to potential BATs. For example, during APS construction of beamlines, the user generated funds were exempt from all overhead. The PAC would also like to have a presentation on overhead definitions and management in a future meeting.
- The PAC would like the project management to revisit the ‘key performance parameters’ to be included in the project execution plan. A major concern is defining the number of beamlines to be delivered. We are not convinced that six state-of-the-art beamlines can be constructed with the indicated budget and thus scope contingency should be examined. The project should retain the flexibility to optimize number and performance of beamlines within the trust fund concept.

Accelerator Systems:

- The PAC was impressed by the progress made in further optimizing the lattice. The introduction of triplet focusing in the straight sections and the adjustment of the bending magnet lengths has provided more space for insertion devices in the short as well in the long straight sections. Additional space has been introduced in the dispersive section close to the bending magnet for the implementation of three pole wigglers (TPW).
- A conservative approach for the basic lattice has been adopted which is supported by the PAC, since several add-in features will deteriorate the dynamic behavior of the lattice and therefore an enlarged margin is required. These additional elements are the damping wigglers to further reduce the emittance and to shorten the damping time, the above-mentioned TPWs, canted insertion devices, in-line insertion devices with refocusing in between, and canted low gap/low period in vacuum undulators with double beta function minimum in order to reach the highest brilliance for hard X-rays.

The PAC appreciates that additional studies are ongoing to further fine-tune the lattice. The need for the central quadrupole in the dispersive region is under investigation. As pointed out, its elimination would in addition reduce the number of sextupoles by one unit per cell.

The committee believes that TPWs inserted in short straight sections adjacent to the bending magnets provide the most flexible solution for generating hard X-rays for the beamlines transferred from NSLS. An alternative solution would be a bending magnet with discontinuous field and 1 Tesla field strength (as the TPW) at the end of the magnet. This is a more complex, less flexible, and presumably more expensive solution but has a pronounced advantage for the dynamic aperture. The sextupoles would be at more favorable positions with higher beta function decoupling, and the horizontal beta function would be confined to smaller values since the quadrupoles could be placed closer to the bending magnet. Therefore, if problems with the dynamic behavior were to arise for the TPW configuration, the bending magnet solution could be evaluated.

The Committee is of the opinion that a magnet with the proper field quality can be fabricated and that a break in symmetry introduced by installing only a few of these discontinuous field bending magnets would not severely affect the dynamic aperture.

- The PAC agrees with the positive comments from the ASAC, especially regarding readiness to begin prototyping major components in the procurement process, the timeline for construction of the accelerator subsystems, plans for achieving and controlling the beam stability, use of Cornell RF

cavity technology, adequacy of shielding, and vacuum chamber design. As recommended by ASAC, the PAC also encourages the NSLS-II team to look at the option to integrate the correction elements in sextupoles. By appropriate wiring the additional coils can also be powered as skew quadrupoles. It has to be verified that a possible small change of the magnetic axis of the sextupole has a very small effect on the performance of the beam. A lot of free space could be generated in this way and if the additional coils are introduced in all sextupoles, a high flexibility for orbit and vertical emittance compensation could be provided.

The ASAC has repeatedly recommended the integration of short straight sections in the lattice for the accommodation of short period and low gap in vacuum undulators. As an alternative, one could explore the possibility of introducing canted devices with focusing elements in between in order to generate double minima for the horizontal and vertical beta functions.

- The concept for the implementation of extra long straight sections, from the beginning or as upgrade in the future is appreciated by the Committee. Such long straight sections would be ideal for long period polarized twin undulators and manifest a high potential for new ideas that arise in the future. The adjacent short straight sections with reduced lengths would be perfect positions for short, small period, low gap in vacuum insertion devices.
- The PAC suggests that minor changes be made to the geometry of the storage ring tunnel design at three symmetric locations to accommodate future 16-18 m long straight sections. This altered storage ring tunnel geometry should be included in the CD-2 validation process and costed in the project.
- Locating the booster ring outside the storage ring tunnel is a prudent decision which will help the construction schedule of conventional facilities, accelerator subsystems, and beamline front ends; also maintenance and operator training during operations would be facilitated.
- The new booster outside the storage ring will fulfill the requirements for top-up injection at 3 GeV as demonstrated by simulations. A loss free injection from the booster into the storage ring is achievable. Nevertheless, a certain margin has been given up since the emittance is increased from 10 to 35 nm. If the 3.6 GeV operation that has been discussed is a serious option, the emittance will further increase to 50 nm. It still has to be demonstrated that this emittance will not jeopardize top-up injection, which is an essential feature of a new generation light source.
- The Committee endorses the selection of a superconducting RF system. It is the ideal system for limiting the excitation of couple bunch instabilities which have a strong impact on the quality of the undulator spectrum. Longitudinal coupled bunch instabilities are enhancing the energy spread in the beam which has a particular harmful effect on the higher harmonics of the spectrum. The Cornell superconducting cavity is the preferred choice. This has been commercialized by ACCEL Instruments GmbH, which recently became a part of Varian Inc. It has to be verified at an early stage that these activities will still be maintained by Varian.
- Because of the importance to effectively combat multi bunch instabilities, the PAC recommends installation of the passive superconducting higher harmonic cavity right from the beginning. Such a system does not only improve the Touschek lifetime but also reduces the excitation of coupled bunch instabilities.
- The PAC is also appreciative of the quick response on the suggestion to relocate (90 degree turn) of the linac and related structures to provide flexibility for future use of the linac.
- The Beam Stability Workshop has provided very useful guidance. In performing a full analysis of beam stability issues, the PAC would suggest that the need for a full concrete slab under the storage ring structure should be revisited with the option to provide concrete pedestals only below the supports. Again this is a subject for value engineering and should be addressed with an open mind by the engineering staff.

- The PAC agrees with the ASAC that any future upgrade plans to provide an ERL injector to NSLS-II will improve the ultimate brightness by an amount that is incommensurate with the magnitude of the extra costs required, and hence should not be pursued at this time.
- The present design capability of injection with minimum loss bodes well for the top-up operation. The PAC encourages implementing top up operation very early, preferably before CD-4b. To avoid any issues of radiation on the experiment floor during this implementation, it could be planned for night shifts.
- The PAC appreciates the requested additional presentation on R&D in support of construction in the accelerator area. These R&D plans should be managed just like the construction project with R&D WBS, goals, milestones and timelines. These elements must correlate with the appropriate element of the construction project WBS. (See PAC Report from October 2006 meeting). The R&D activities must be managed along with the corresponding project elements by the Project Management directorate. Open ended R&D items such the development of new superconducting materials/structures do not belong to a construction project, although such R&D must be pursued with other funding sources such as LDRD or DOE Programmatic funds.
- One of the challenging R&D areas for the insertion devices group will be the development of a working prototype in vacuum undulator. We strongly urge that EF personnel to be intimately involved with this development, participate in the testing of the prototype at various stages of development, and assure that the device specs and performance satisfy the needs of the BAT scientific program.
- The PAC has not heard much on the control system for the accelerator and would like to hear more at the next meeting.

Conventional Facilities:

- The PAC endorses the findings of the CFAC.
- The PAC is pleased to note the actions resulting from the thorough study conducted by the Beam Stability workshop. The PAC is pleased that CF plans to include all the recommendations, both by finding solutions for vibration mitigation and meeting the temperature stability in the storage ring tunnel and the experiment hall.
- The PAC wants to point out that the sensors for temperature control and the HVAC vents must be placed parallel to the beamlines with tangential geometry in the Experiment Hall so that the temperature control is provided to an experimental sector on the floor.
- We encourage a very aggressive approach to early procurement of AE and related consultant services as soon as the funds are made available this fiscal year. Partial or full packages for these activities should be readied now.
- The PAC is pleased to see the outcome of the exercise to define the space required to house the personnel for full facility operation and consequent layout of the buildings. However, the complete removal of the CLO building was unfortunate. The PAC echoes the ASAC recommendation to provide space where the CLO was planned for personnel involved in day-to-day operation of the accelerator systems such as machine physicists, shift operators, and subsystem managers. It is equally important that this location also provide space for NSLS-II upper management, and facility administrative staff. PAC welcomes the idea of having a central structure added as appropriate for these functions.
- The PAC endorses the use of existing NSLS space for NSLS-II activities, such as the suggested conversion of the VUV-IR ring area to an auditorium. We encourage the imaginative use of space

throughout NSLS for appropriate functions. The cost for such rehab work should not be a part of the NSLS-II project.

- A full technical specification should be prepared by the two technical divisions (EF and AS) for the needs of various subsystems. These specs should then be translated to develop the functional specifications of the CF structures and requirements. This list must be frozen along with scope for all buildings and support structures for AS and EF, and all WBS at all levels. All three DDs and interface managers should agree and sign such a specification document (in blood) along with project director or his deputy, who could steward this activity. Special attention should be given to the location of the following: maze between various accelerator systems, conflict in process piping, ductwork (e.g., vents from storage ring tunnel), fire protection sprinklers, electrical, light location on the floor and the tunnels, cable and plumbing layouts (with 3D CAD drawings), beamline electrical boxes on the experiment floor, survey monuments, conflict of caissons with line-of-sight of beamlines to be extended from the experiment floor, electrical tray locations on the outside (on the experiment floor side) and inside of the storage ring (e.g., unistrut channels embedded in the storage ring concrete wall), ratchet door locations, and location and number of conduits (with no direct line-of-sight stopping radiation leak) to carry cables and utilities from storage ring tunnel to experiment floor or in-field. These interface specifications carry the potential to drive cost growth if care is not taken to insure project optimizations (as opposed to sub-system optimizations) are made.
- A complete project 'electrical power need' spread-sheet must be prepared including all the functions in the WBS. The input for such a plan must come from all the divisions of the project.
- Special consideration should be given to electrical grounding at the outset with input from both AF and EF divisions.
- The PAC has some concerns about the large dome-type roof over the experiment hall. It will be necessary to introduce penetrations in this roof as the operations of the experimental program progresses. The input from CFAC should be sought before finalizing the roof style. There may be opportunities for cost savings with added capabilities.
- The PAC strongly urges all three divisions to collectively organize 'value engineering' workshops and find solutions that are adequate to meet the functions and save on costs.

Experimental Facilities:

- The PAC is generally pleased with the findings of the EFAC, including the range of science programs that will take advantage of the capabilities at NSLS-II from hard x-ray to the IR range
- The enlargement of the EFAC to provide broader community input is very encouraging. It is hoped that a bigger attendance of the EFAC membership at future meetings will provide broader insight to the project team.
- The new configuration and the expansion capability of the LOBs meets previously identified shortcomings of lab/office space for the users and lab/office space for EFAC staff supporting the users.
- The PAC suggests a closer examination of the technical specifications of the initial project beamlines including the choice of IDs. It is important to plan any beamline at NSLS-II with a BAT input whether it represents the first beamlines in the project or the beamlines to be developed to meet the needs of NSLS users. The upcoming user workshop in July 2007 is an important opportunity for obtaining immediate user input on this critical issue.
- The identification of initial project beamlines should be established based on input from the user community. These decisions should be based on the strength, size, and vision of potential users.

Careful consideration should be given to sharing beamlines for different kinds of experiments without compromising the proposed experiments. All experiments on these beamlines should take advantage of unique capabilities of NSLS-II in the context of existing US facilities. Particularly with the ID beamlines it is essential that any beamlines to be constructed at NSLS-II be demonstrably “Best-in Class” – i.e. installed instrumentation should perform at or above the state of the art independent of gains in source performance.

- NSLS-II should be proactive in organizing the community to plan the science program as it did in the series of workshops that it sponsored prior to the submission of the original proposal to DOE. The suggested ‘BAT Council’ could help in this effort. Funds should be allocated to support travel of these groups to user meetings and additional workshops.
- The PAC is concerned about prospects for support and integration of beamlines for research areas outside the BES mission, notably those in the life sciences and environmental sciences. Macromolecular crystallography is a dominant element at every thriving synchrotron facility, including NSLS, and it is essential for ultimate success of NSLS-II that this community be retained and nurtured. As the MIE mechanism does not seem to be available for biological sciences, it is important that NSLS-II play an active role in developing alternative funding sources and beamline development programs to engage this community from the very outset of operations.
- The PAC endorses the inclusion of 15 triple-bend wigglers (TPWs) as a part of CD-2 which provides higher critical-energy sources at NSLS-II. (See comments in the Accelerator Systems section above)
- The NSLS and NSLS-II teams have generated preliminary criteria for developing a transition plan for beamlines from NSLS to NSLS-II requested by the PAC at their last meeting. The selected criteria (publications and beamline usage) for selection have provided some insight in developing such a plan. The PAC feels the most important criterion in developing such a plan is the scientific impact of these beamlines in 2015. Only beamlines, or components of beamlines, with the technical capability to deliver impact in the 2015 timeframe should be candidates for relocation.
- NSLS-II should insure that policies for BAT beamtime allocation, particularly for non-BES funded BATs retain some flexibility for tailoring to meet the needs of particular sponsors or programs. This should be within the overall framework of transparency and peer review but not so rigid it precludes a diverse funding and science base. In contrast to SNS or LCLS, NSLS-II has some capabilities which are not internationally or nationally unique (bending magnet beamlines for example). In those cases finding a mechanism for increased BAT buy in and involvement through a partner user arrangement or programmatic research proposals for block beamtime should be explored. In either case the principle of peer review is respected but a longer term (say 3-5 year) commitment will deepen the involvement of the Team with NSLS-II.
- The PAC is very encouraged by the commitment of the DOE to fund additional beamlines through MIE funding calls, as early as in 2009. It is imperative that NSLS-II management prepare a formal process to encourage highest quality user participation in such an effort so that ‘best among equals’ class of undulator beamlines is proposed. Such a plan should be ready by 2008 and should take the full benefit of advice from various advisory committees and senior members of the community. The PAC has some concerns that if many NSLS users are engaged in a beamline transfer plan (e.g., to the triple bend wiggler lines), there may not be a community of users interested in a BAT participation in MIE-funded undulator beamlines (and possibly competing demands for resources). In the long term the new capabilities of the NSLS-II ID beamlines will drive novel science and should have the corresponding priority. Again, NSLS-II needs to play a leadership role in cultivating the community to develop forefront science programs at its premier beamlines. JPSI has an important opportunity to contribute to this effort and attract new users to NSLS-II.

- The PAC is concerned about the organization of the EF division shown in the project chart. It is prudent to organize groups around functions rather than around the people who are hired. The suggested R&D groups do not have a place in this organization. Such R&D personnel should be managed by the WBS task groups, in this case beamline groups. We also suggest that the detector R&D is an open ended R&D which will benefit the entire NSLS-II user community. As mentioned above, detector R&D is best served if it is a part of JPSI or an independent R&D team reporting to the NSLS Director. If x-ray optics metrology hardware is to be procured as a part of the NSLS-II project with intent to establish an X-ray Optics Metrology Facility at NSLS-II, we suggest that a group with this function be included in the EF organization from the beginning. This group will provide R&D in support of the planned beamlines in the construction project. For example, it will not only perform R&D for developing 1 nm optics, but also high heat load optics, mirrors needed for various beamlines, and 0.1 meV optics. This facility could be a modern version of the facility operating at the APS.
- The WBS breakdown for Experimental Facilities should reflect the deliverable subsystems, similar to Accelerator Systems. In the case of EF they are the beamlines included in the construction project, project management, beamline controls and perhaps the metrology facility. The PAC strongly urges a recast of the current WBS.
- The EF management should keep a very close oversight on the scope and costs included in AF and CF. Savings in these areas translate to urgently needed increase in the scope for EF beamlines.